云 南 植 物 研 究 7(4): 429—435, 1985
Acta Botanica Yunnanica

从西藏金发藓科植物初步研究兼论青藏高原的隆起

徐文宣 熊若莉

(云 南 大 学 生 物 系)

摘要 西藏金发藓科植物，已知有7属，30种，4变种；其中新种5个，新变种3个。从水平分布看，大多集中雅鲁藏布江流域附近，因该流域是印度板块北缘与欧亚大陆南缘的缝合线，因而金发藓科植物得以高度集中。本文讨论了该科在本区的地理分布和区系成份的分析等问题，并讨论了青藏高原的隆起对该群藓类的影响。

关键词 西藏；金发藓科

一、西藏金发藓科植物的分类及分布

中国科学院青藏高原科学综合考察队，经多年的采集调查，西藏地区所采金发藓科植物标本近300号，据我们初步鉴定，共7属，28种，4变种，其中新属1（与云南共有），新种5，新变种3，包括《珠穆朗玛峰地区科学考察报告》（1962）所报道的黄尖金发藓（Polytrichum xanthopilum）及1959年W. Mitten发表西藏地区采集的喜马拉雅小金发藓（Pogonatum himalayanum）共计30种4变种[3]。

西藏金发藓科植物的水平分布通常集中于雅鲁藏布江流域附近的藏南及藏东南等地区，东起昌都，南至亚东，西达仲巴，北到比如，其间包括拉萨市及21县为其主要分布区。

金发藓科植物的垂直分布规律，与种子植物的分布大体相同[2]，现划分为以下各带。

1.高山荒漠带(海拔5000米以上，2种1变种)：Polytrichum crassilamellatum, Pogonatum thomsonii var. tibetanum, P. setschwanicum.

2.高山草甸带（海拔5000—4500米，6种1变种）：Polytrichum tibetanum, P. alpinum var. fragariiforme, Lyellia minor, Pogonatum perichaetiale, P. setschwaicum, P. tortipes, P. urnigerum.

3.高山灌丛带（海拔4500—4000米，7种1变种）：Pogonatum perichaetiale, P. setschwanicum, P. tortipes, P. spurio-cirratum, Oligotrichum falcatum,

---

本文于1984年12月19日收到。

O. semilamellatum, O. serratimarginatum, Polytrichum juniperinum var. piliferoides.

4.针叶林带（海拔4000—2800米，15种2变种）：Pogonatum microstomum, P. microstomum var. ciliatum, P. perichaetiale, P. submicrostomum, P. setschwanicum, P. spurio-cirratum, P. thomsonii, P. thomsonii var. tibetanum, P. tortipes, P. urniqerum, Polytrichum gracile, P. formosum, P. juniperinum, P. piliferum, Atrichum henryi, A. obtusulum, Microdendron sinense.

5.阔叶林带（海拔2800米以下，11种）：Lyellia crispa, Pogonatum aloides, P. cirratum, P. inflexum, P. microstomum, P. perichaetiale, P. submicrostomum, P. thomsonii, P. tortipes, Neopogonatum tibeticum, Atrichum undulatum.

由上述可见苔藓植物不仅能生于种子植物不能生长的高山荒漠带，同时与森林的关系也比较密切，其中针叶林中种类较多，据初测的结果，该科植物要求土壤酸碱度在pH5.5—6.5间，说明该类植物具有需光喜酸的习性，几成针叶林下地被物的主要组成成份。

二、西藏金发藓科植物的地理分布及区系成份的初步分析

西藏金发藓科植物种类虽然不多，根据不完全的统计，在下列十个地区均有分布。

1.云南省（21种1变种，占该地区全科之60%）：Atrichum henryi, A. obtusulum, A. undulatum, Oligotrichum semilamellatum, Pogonatum aloides, P. cirratum, P. inflexum, P. microstomum, P. microstomum var. ciliatum, P. perichaetiale, P. submicrostomum, P. setschwanicum, P. spurio-cirratum, P. thomsonii, P. tortipes, P. urnigerum, Polytrichum alpinum, P. formosum, P. juniperinum, P. piliferum, P. xanthopilum, Microdendron sinense.

2.锡金、尼泊尔、不丹（7种，占20%）：Lyellia crispa, Pogonatum aloides, P. inflexum, P. tortipes, P. urnigerum, Polytrichum alpinum, P. xanthopilum.

3.印度（17种，占50%）：Atrichum obtusulum, A. undulatum, Lyellia crispa, Oligotrichum semilamellatum, Polytrichum formosum, P. alpinum, P. juniperinum, P. piliferum, Pogonatum aloides, P. cirratum, P. inflexum, P. microstomum, P. himalayanum, P. tortipes, P. urnigerum.

4.我国台湾及日本（12种，占30%）：Atrichum henryi, A. undulatum, Pogonatum aloides, P. inflexum, P. spurio-cirratum, P. thomsonii, P. urnigerum, Polytrichum alpinum, P. formosum, P. gracile, P. juniperinum, P. piliferum.

5.菲律宾（3种，占10%）：Atrichum undulatum, Pogonatum microstomum, P. spurio-cirratum.

6.大洋洲（4种，占11%）：Atrichum undulatum, Polytrichum alpinum, P. juniperinum, P. piliferum.

7.印度马来亚（2种，占5％）：Pogonatum aloides, P. microstomum.

8.北极（1种，占2.6％）：Oligotrichum falcatum.

9.欧洲（8种，占23％）：Atrichum undulatum, Pogonatum aloides, P. urnigerum, Polytrichum alpinum, P. formosum, P. gracile, P. juniperinum, P. piliferum。

10. 非洲及北美洲（7种，占22％）：Atrichum undulatum, Pogonatum aloides, P. urnigerum, Polytrichum alpinum, P. formosum, P. juniperinum, P. piliferum.

由上述可以看出，西藏金发藓科的分布与我国云南及印度的关系更为密切。

由西藏金发藓科植物各种的地理分布，初步分析有以下各种区系成份。

（1）世界种（2种，占5％）：Polytrichum formosum, P. juniperinum.

（2）泛北极成份（5种，占14％）：Oligotrichum falcatum, Atrichum umdulatum, Pogonatum urnigerum, Polytrichum gracile, P. piliferum.

（3）古热带成份（3种，占9％）：Pogonatum aloides, P. cirratum, P. spurio-cirratum.

（4）东亚成份（7种1变种，占22％）：Atrichum henryi, A. obtusulum, Pogonatum inflexum, P. microstomum, P. perichaetiale, P. microstomum var. ciliatum, P. setschwanicum, Microdendron sinense.

（5）喜马拉雅成份（9种，占25％）：Lyellia crispa, Oligotrichum semilamellatum, Pogonatum himalayanum, P. microstomum, P. submicrostomum, P. tortipes, P. thomsonii, Polytrichum alpinum, P. xanthopilum.

（6）特有成份（5种3变种，占24.5％）：Lyellia minor, Oligotrichum serratimarginatum, Pogonatum thomsonii var. tibetanum, Neopogonatum tibeticum, Polytrichum alpinum var. fragariiforme, P. crassilamellatum, P. juniperinum var. piliferoides, P. tibetanum.

上述分析，可见喜马拉雅成份与西藏特有成份占该地整个植物种类的50％，是因高原隆起对植物区系的改变与形成起着十分巨大影响的结果。

三、从西藏金发藓科植物初步研究，兼论青藏高原隆起后对该类植物的影响

我们对西藏金发藓科植物的分类、分布及区系成份的初步分析，由以下事实可以看出青藏高原隆升后对该科植物的各种影响。

1.从分布区域看。西藏地区采集的金发藓科植物标本，主要集中分布于藏东南及藏南地区，本区正位于雅鲁藏布江流域，按照板块学说，恰是印度板块北缘与欧亚大陆南缘的缝合线上，金发藓科植物主要集中分布在这一区域，固然是因为河谷流域较为湿润，但更重要的是由于印度板块向北俯冲，青藏高原隆起，古地中海消失，使欧亚大陆与冈瓦纳古陆直接相连，因而此一区域不仅是南北古陆的交界处，也是东南太平洋季风

和西南印度洋季风的接触地带，所以金发藓科植物种类得以高度集中。同时因受印度板块的冲击，青藏高原迅速和持续隆起，所以本科植物的垂直分布也极为明显，最高海拔为5600米，如厚栉金发藓（Polytrichum crassilamellatum）生于冰碛物上，最低海拔为800米，生长的种类如扁蒴藓（Lyellia crispa），小金发藓（Pogonatum aloides），生于较温暖的热带季雨林，此两种植物为我国西藏地区的新纪录，但它们又是与印度锡金等地的共有种，可能是两个板块并合后，由印度板块通过锡金，不丹，尼泊尔等地传播到西藏较低海拔地区的证据之一。

2.从植物种系发生看，西藏金发藓科植物据我们的鉴定及以往的记录，全科7属，种及变种34个，7个属全与云南共有，西藏地区无特有属，但新种及新变种共有8种，占总数的24%。由古植物资料，苔藓植物是一群古老的植物类群，出现于古生代的泥盆纪，经过数亿年的漫长岁月，它们科一级和属一级的种系发生已相对稳定，因第三纪隆升后，地层年青，新科和新属尚未形成，但是由于高原隆升以后，气温下降，自然环境发生显著变化。在新环境的影响下，只可能发生种一级的分化，产生了较多的新种和新变种，所出现的新种和新变种，不仅数量多，而且生长的海拔大多比较高，如厚栉金发藓分布5600米，西藏小金发藓（Pogonatum thomsonii var. tibetanum）分布5400米，其他如小扁蒴藓（Lyellia minor），草莓疣金发藓（Polytrichum alpinum var. fragariformis），西藏金发藓（P. tibetanum），都在4500米以上，由此可见金发藓科植物种系发生，在青藏高原隆升过程中所引起的显著变化。

3.从地理分布看，青藏高原为世界最高海拔地区，有世界屋脊之称。按照藓类生活适应看，该科植物种类应以高寒种类即泛北极成份为主，可是从西藏该科植物地理分布及区系成份看来，它们不仅与邻近的区域如云南、尼泊尔、不丹、锡金、印度等地有密切关系，而且还与我国台湾及日本、菲律宾、大洋洲等地区都具有共同的种类。此现象的出现，是因为第三纪以前，青藏地区为古地中海，到了第三纪末期，该地区才全部脱离海水成为陆地，因而各板块之间的物种得以互相渗透，而且隆起之初，气温较高，所以生长了某些热带种类，如拟刺边小金发藓（Pogonatum spurio-cirratum），刺边小金发藓（P. cirratum），及扁蒴藓等得以保留下来，而且又加入了各板块的种类，因而形成了复杂的成分。

4.从适应的观点看，生物种类的发生和发展，与环境有着密切的关联。一般规律，适者生存，不适者淘汰。在青藏高原隆升过程中，也出现了类似的情况，例如镰叶小赤藓（Oligotrichum falcatum）是北极地区格陵兰岛与阿拉斯加的特有种，近年在西藏的墨脱至米林县之间海拔3600—4200米处发现，因而由特有种成为间断分布，这可能是青藏高原隆升后，气温下降，环境适合该种植物的生长发育，虽然两地距离很远，但因苔藓植物的孢子细小，易于随风传播，到了适合的地区，就可以定居下来得到发展。或因由古大陆将藓类从北方南延或保留下的残迹。相反如土马鬃（Polytrichum commune）在亚洲北部和中部，欧洲、美洲、大洋洲、非洲均有分布，在我国各省区的平原高山地带皆能普遍生长，几成为世界种，但在西藏地区则未发现，因为本种植物喜生泥炭沼泽带常与泥炭藓（Sphagnum）混生，由于青藏高原隆升以后，自然条件发生变化，泥炭藓种类减少，没有发育为泥炭沼泽，失去了生存条件，因而该种植物也就随之消失了，这

也是隆升过程中物种发生变化的现象之一。

5.从区系成份看，由西藏地区金发藓科植物区系成份的初步分析，可以看出在西藏植被中，古热带成份和泛北极成份的结合和分布，例如拟刺边小金发藓（Pogonatum spurio-cirratum）与疣小金发藓(P. urnigerum)，一为古热带成份，一为泛北极成份，但它们不仅分布在同一地区，而且还同时生长在2800—4000米的针叶林带，甚至表现在同一属内，成为双重的热带—泛北极的性质，这种双重性质，也是新隆起地层的特点之一。同时西藏金发藓科植物，除前述两种成份外，其他如东亚成份，喜马拉雅成份及特有成份，基本上属于东亚成份，与吴征镒等[2]划分的泛北极植物区，青藏高原植物亚区中的喜马拉雅地区的分区意见是相吻合的。

参 考 文 献

〔1〕 Arnold, C. A., 1947: Am Introduction to Paleobotany. p. 58 Mc Graw-Hill, Book Co.

〔2〕 Wu Zheng-yi, Tang Yan-cheng etc., 1981: Dissertation upon the origin, development and regionalization of Xizang flora througn the floristic analysis. In Geo. and Ecological studies of Qinghai-Xizang plateau, Vol. Ⅱ: 1219—1233. Science Pres & Gordon and Breach, Sci. Pub. Inc.

〔3〕 Zang Mu et Li Xing-jiang 1981: The Bryological Exploration of Xizang (Tibet). *Nova Hedwigea* 71: 337—339.

A TENTATIVE EXPLANATION, BASED ON THE PRELIMINARY STUDY OF TIBETAN POLYTRICHACEAE, OF THE UPLIFT OF QING-ZANG PLATEAU

Xu Wenxuan and Xiong Ruoli

(Department of Biology, Yunnan University, China)

Summary From the following facts it follow that the Qing-Zang plateau began to elevate since the Tertiary.

1. From the viewpoint of the area where we discovered the plants.

We have a survey of the Polytrichaceae in Tibet mainly distributed in SE. Tibet and S. Tibet. This area is just along the valley of the Yalu Tsangpo (Yalu Tsangpo River). According to the theory of the continental drift, this area may well be the seam where the northern edge of the India plate and the southern edge of the continent of Asia meet. Thus the plants of this area include not only the elements of Laurasia, but also those of Gondwanaland. As a result of this, the plants of this area are characteristic of complexity of ele-

ments and greatness of species. It is because of the crash of the India plate and the continent of Asia that the Qinghai–Xizang (Chinghai–Tibet) area is uplifted by the impact of the crash. And at the same time it is becomes obvious that the plants distribute vertically. For example, *Polytrichum crassilamellatum* is the highest among them, alt. 5600 m. *Pogonatum aloides* and *Lyellia crispa* are the lowest, alt. 800 m, The latter is the latest entry in the bryo-flora from Tibet. The time it disperses to Tibet area may be after the combination of the two continents.

2. From the viewpoint of the species of the plants.

According to our determination, in Polytrichaceae there are 7 genera, 30 species, 4 varieties including 1 new genus, 5 new species, 3 new varieties. But there is no endemic genus among the 7 genera. Although there is a new genus, the *Neopogonatum*, yet it is also common with Yunnan. There are, however, 8 new species and new varieties altogether, 24% of all its species. For bryophytes were a group of older plants which took place in the Devonian of paleozoic. Many years had passed before the Tertiary of Cenozoic era. The phylogeny of family and genus stage had been done before for new families and new genera to take place. On the contrary, since Tertiary the environment changed greatly with the upwardness of the plateau, some species took place to adapt themselves to the new environment. Then the differantiation at the level of species amounted to 24%. It can be seen from this that there was a great change before and after the stratum uplift in phylogeny of species.

3. From the viewpoint of the common species in other areas.

The Chinghai and Tibet areas is known as the ridge of the world for its high altitude. Thus its plants are supposed to have been species of high mountains with cold weather. Yet among the 34 species we analyze, there are more or less common species with those in Japan, Philippines, Oceania, Africa and America and so on, as well as with those in its neighbouring areas such as Yunnan, Sikkim, Bhutan, Nepal, India. Why so ? It is estimated that the Tethys of Qing-Zang area began to get entirely rid of sea water and to become land since late Eocene period of Tertiary. As a result of this, it was at that time that diverse species took place and the species of the different areas intermingled with each other. However, some of tropic species survive there after the India slate drifted northward and crashed with the continent of Asia and made the strata there uplifted. It is a case in point for an uplift.

4. From the viewpoint of the adaptability of species.

According to the theory of the survival of the fittest, those who adapt themselves to the environment live and those who do not disappear. For example,

Oligotrichum falcatum, which is an endemic species in Greeland and Alaska in North pole, can now be collected from the altitude of 3600—4200 m Medog Mainling Xian (Meto-Milin County), Tibet. This is a case of disjuction. The downwardness of the temperature there after the uplift of the Qing-Zang plateau is suitable for the living of the species. But the Qing-Zang plateau is quite far from Greenland and Alaska. They may be carried there by the wind for they are so small and light. On the contrary, *Polytrichum commune* distribute widely in Europe, America, Oceania, Africa, Northern Asia and Central Asia, as well as the plains and the areas of high mountainns all over China. However, this species likes to live in peat bogs and often intermingles with *Sphagnum*, but the environment changed after the uplift of Tibet, there were no peat bogs for them. This is a proof of that a living thing disappears for being not adaptable to the environment.

5. From viewpoint of the elements of bryoflora.

In the bryoflora of Xizang (Tibet) we can find out the combination and distribution of the elements of tropic and North pole in vegetation, Such as *Oligotrichum falcatum*, *Polytrichum gracile*, *Pogonatum urnigerum* in the elements of Holarctic and *Pogonatum aloides*, *P. cirratum*. *P. spurrio-cirratum* in the elements of old world tropic. We also find that there is a relationship between the tropical species and holarctic species in the same genus. This double quality of the tropic and holarctic is also one of the features of the newly-uplifted strata. Besides, from the viewpoint of most species of Polytrichaceae, they mainly belong to the elements of E. Asia. It shows that when these two slates crashed, the India slate was under, the southern edge of the continent of Asia was caused to rise upwards. Thus it is possible that the elements of E. Asia are concentrated there.

Key words Tibet; Polytrichiaceae